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Inventor(s): BARKER COLIN JOHN; BARKER JACK ABBOTT; CLEMENTS RONALD ;

Applicant(s): REDBAR PLANT HIRE PTY LTD ;

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ABSTRACT:

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(54) COUPLING FOR DETACHABLY MOUNTING EARTH WORKING TOOLS

(71) REDBAR PLANT HIRE PROPRIETARY LIMITED

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(43) 30.5.85

(51)3 E02F 3/96

(72) COLIN JOHN BARKER

(74) HA

(57) Claim

1. A coupling for detachably mounting a tool having two mounting members on earth working apparatus, the coupling comprising a coupling body, means in said body to enable securement thereof to the apparatus, hook means on the coupling body and adapted to extend part way around a first of the mounting members, recess means in the coupling body and adapted to receive the second of the mounting members with the hook means and recess means being arranged such that the hook means must be engaged before the recess means with the respective mounting members, hydraulically operable securing means disposed in the coupling body and moveable relative thereto between a locking position in which withdrawal of the second mounting member from the recess means is prevented when the first mounting member is received in the hook means and a release position in which such withdrawal is permitted, and spring biassing means which acts to bias the securing means into the locking position.

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COMPLETE SPECIFICATION

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Complete Specification—Lodged:
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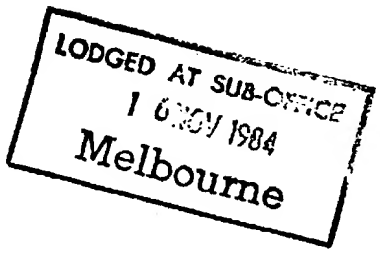
Related Art:



TO BE COMPLETED BY APPLICANT

Name of Applicant: REDBAR PLANT HIRE PROPRIETARY LIMITED

Address of Applicant: 94 Newlands Road, Reservoir, Victoria 3073, Australia.

Actual Inventor: Colin John BARKER, of 145 St. Helena Road, Greensborough Victoria 3088, Australia; Jack Abbott BARKER, of 34 Manatunga Circuit, Greensborough, Victoria 3088 Australia; and Ronald CLEMENTS, of 31 Churchill Avenue, Reservoir, Victoria 3073, Australia.

Address for Service: CLEMENT HACK & CO.,
140 William Street,
Melbourne, Vic. 3000.
Australia.

Complete Specification for the invention entitled:

EARTH WORKING APPARATUS AND A COUPLING THEREFOR

The following statement is a full description of this invention, including the best method of performing it known to me:—

PF/CP1F/2/80

EARTH WORKING APPARATUS AND A COUPLING THEREFOR

This invention relates to earth working apparatus, such as a hydraulic excavator, and is particularly concerned with a coupling for detachably mounting a tool such as a bucket thereto.

Hydraulic excavators having a ground supported body and a pivoted boom extending therefrom to the remote end of which an earth working tool such as a bucket is connected, are well known. The boom is usually defined by at least two relatively pivoted rigid arm members, the outer one of which carries the earth working tool, and the relative angle of the boom to the body and of the arm

members to each other is usually adjustable by hydraulic rams. Similarly, it is usual for the earth working tool to be pivotally adjustable relative to the boom and this is usually allowed for by providing a pivot connection for the tool on the remote end of the outer arm member and a further pivot connection on the tool for one end of a hydraulic ram whose other end is secured relative to the boom.

It has been usual to provide removable fixedly spaced locking pins as said pivot points on the earth working tool, the pins being engageable with corresponding openings in the remote end of the outer arm member and the last-mentioned hydraulic ram.

It is often necessary to change the earth working tool on a hydraulic excavator, for example to exchange one bucket for a bucket of the same size but with a new set of teeth, or to fix some other tool such as a hammer, ripper, vibrator or rock grab. In order to do this, it is necessary to remove the locking pins, align the cooperating openings in the new tool and the excavator and reinsert the locking pins. Even with experience, it has been shown that this procedure may take 30 minutes or more.

In order to reduce this downtime it has been proposed to provide a coupling which is permanently mounted on the machine and which provides a quick-acting arrangement for attaching and releasing a tool. Two such proposals are in International Patent Applications 82/02731 and 83/03629, in both of which a hydraulically operable securing member is extendable to lock the coupling onto the tool.

One problem with many previously proposed quick-acting couplings of the type disclosed in the above International Applications is that they have a tendency not to securely mount the tool thereto. It must be

remembered that substantial forces may be applied to the coupling. Thus, a bucket may be used for digging as well as for lifting more than one tonne of earth, and accidental release of the bucket may cause substantial damage.

Furthermore, a coupling which requires every tool which is to be mounted thereon to have special mounting members welded or otherwise fastened to the tool presents considerable commercial disadvantage to the operator even though the coupling may permit the tool to be mounted quicker than would otherwise be the case.

It is an object of the present invention to provide an improved coupling for tools to be attached to earth working apparatus.

According to the present invention there is provided a coupling for detachably mounting a tool having two mounting members on earth working apparatus, the coupling comprising a coupling body, means in said body to enable securement thereof to the apparatus, hook means on the coupling body and adapted to extend part way around a first of the mounting members, recess means in the coupling body and adapted to receive the second of the mounting members with the hook means and recess means being arranged such that the hook means must be engaged before the recess means with the respective mounting members, hydraulically operable securing means disposed in the coupling body and moveable relative thereto between a locking position in which withdrawal of the second mounting member from the recess means is prevented when the first mounting member is received in the hook means and a release position in which such withdrawal is permitted, and spring biassing means which acts to bias the securing means into the locking position.

The spring biassing means therefore acts in conjunction with the hydraulically operable securing means to hold the securing means in the locking position and the force of the spring biassing means must be overcome to move the securing means into the release position. Preferably the spring biassing means applies sufficient force to the securing means that the second mounting member will not be released if there is loss of hydraulic pressure to the securing means.

The means for securing the coupling on the apparatus may comprise openings in the coupling which may be aligned with the aforementioned openings in the earth working apparatus and locking pins which may be passed through the aligned openings. In changing the earth working tool, it will be appreciated that it is not necessary when using the coupling in accordance with the present invention to remove the locking pins or other securing means between the coupling and the apparatus.

The spring biassing means may comprise at least one compression spring acting between the coupling body and the securing means, and preferably the or each compression spring is restrained over at least part of its length from lateral displacement whereby even if the spring distorts or breaks a compression force may still be applied to the securing means.

The two mounting members of the earth working tool may comprise the aforementioned locking pins which are removable from the tool but which need not be removed when removing or fitting tools from the coupling of the present invention. Alternatively such locking pins may be fixed relative to the tool, or the mounting members may be in any other form which permit the hook means to extend part way around one of them and the other to be received by the recess means.

The securing means may take any of several forms, but in a preferred embodiment comprises a slide member which is slidably displaceable through guide means in the coupling body between the locking and release positions. The securing means may have a locking element which in the locking position at least partly closes an open outer end of the recess means to prevent withdrawal of the second mounting member from the recess means. The locking element may be defined by a grooved end face of the securing means.

In a particularly advantageous embodiment, the recess means in the coupling body comprises a side surface at the side thereof closest to the hook means which at least partly defines an outer end of the recess means and the securing means acts to secure the second mounting member in the recess means at a preselected position along the side surface inwardly of said outer end, and the hook means comprises a closed end portion in which the first mounting member is received during use and opens generally away from the recess means, and wherein the spacing of the side surface of the recess means from the closed portion of the hook means does not increase from said preselected position towards said outer end. In this arrangement a tool mounted on the coupling can have mounting members which are spaced substantially equally to the spacing between the closed portion of the hook means and the preselected position along the side surface of the recess means so that displacement of the tool relative to the coupling in the plane of the mounting members is restrained by the hook means and the side surface rather than by the hook means and the securing means. Tolerances will generally mean there is a small amount of slack between the second mounting member and the side surface when the first mounting member closely abuts the closed end portion of

the hook means, but preferably this slack is not greater than about 10 mm. This arrangement tends to reduce the extent to which the securing means projects into the recess means as well as countering forces which might otherwise act on the securing means against hydraulic pressure holding the securing means in the locking position where the securing means extends part way around the second mounting member as with the grooved end face described above.

Also according to the invention there is provided an earth working apparatus including a boom and the coupling of the invention in which a hydraulic ram displaces the securing means between the locking and release positions, the apparatus including fluid pressure supply means for the hydraulic ram. Preferably the fluid pressure supply means includes valve means disposed in a parallel circuit with the hydraulic ram which is biased into a closed position to prevent loss of pressure from the hydraulic ram when there is no fluid pressure supply thereto and which opens to direct fluid pressure to the hydraulic ram.

Advantageously, for safety reasons, the release position of the securing means may not be readily entered, so that any risk of said position being entered accidentally is alleviated. Thus, the fluid pressure supply means may include two manually controlled valves both of which must be opened to direct fluid pressure to the hydraulic ram for example, by two distinct levers in the cab which must be operated separately by two hands. One or both of the levers may be biased away from the position thereof which causes the respective valve to direct fluid pressure to the hydraulic ram to enable the release position of the securing means to be entered. Most advantageously at least one of the valves is electrically actuated.

One embodiment of the invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 shows a side view of an excavating bucket attached by known means to the boom of a hydraulic excavator;

Figure 2 is a similar view to that of Figure 1 but showing the coupling in accordance with the present invention mounted on the remote end of the boom of a hydraulic excavator, with a bucket about to be attached;

Figure 3 is a view similar to Figure 2 but showing the bucket attached;

Figure 4 is a sectional enlarged view of the circled portion of Figure 2;

Figure 5 shows a modified hook of the coupling;

Figure 6 shows a sectional view taken on the line 6-6 of Figure 4;

Figure 7 shows a sectional view taken on the line 7-7 of Figure 6; and

Figure 8 illustrates one embodiment of a hydraulic circuit for controlling the coupling.

Figure 1 shows a prior art arrangement in which a bucket 1 is mounted on the remote end 2 of the boom 3 of a hydraulic excavator about a pivot axis 4 and by a hydraulic ram device 5 whose left hand end (in the drawings, not shown) is pivotally connected to the boom 3. The hydraulic ram device 5 comprises a hydraulic actuator 6 with a piston rod 7 pivotally connected to a longitudinal link 8 which is pivotally connected at 9 to the bucket 1. A cross-link 10 is pivotally connected between the boom 3 and the junction of the piston rod 7 and longitudinal link 8 to ensure controlled pivotal movement of the bucket 1 about axis 4 as the piston rod 7 is extended and retracted.

The buckets in Figures 1 to 3 are identical and it may be seen in Figure 1 that a first elongate pivot pin extends through aligned holes in the bucket 1 and through a hole in the remote end 2 of the boom 3 and that a second elongate pivot pin extends through further aligned holes in the bucket and through a hole in the longitudinal link 8, to define the pivot axes 4 and 9. In order to remove the bucket 1 from the prior art arrangement in Figure 1, it is necessary for the pins defining pivot axes 4 and 9 to be manually removed. Furthermore, in order for a new bucket or other implement to be fitted to the hydraulic excavator, it is necessary for the holes in the boom 3 and link 8 to be manually aligned with corresponding holes in the new implement and for the locking pins to be reinserted.

With reference now to Figures 2 and 3, the arm 3 and hydraulic ram device 5 are identical to those shown in Figure 1, and a coupling 11 shown in greater detail in Figures 4, 6 and 7 is located between the arm 2 and link 8 and the bucket 1.

Referring now to Figures 4, 6 and 7, the coupling 11 comprises two spaced flanges 12 and 13 mounted on a base plate 14 and having respective pairs 15 and 16 of aligned openings therethrough. An annular reinforcing member 17 is welded to each flange around each opening. The hole in the link 8 is aligned with the openings 15 and the hole in the remote end 2 of the boom 3 is aligned with the openings 16, and respective pivot pins are inserted therethrough to define the pivot axes 9 and 4, respectively. Thus, the coupling 11 is mounted on the excavator in precisely the same way as the bucket 1 is in the prior art arrangement of Figure 1, with the spacing of the pivot axes 9 and 4 preferably being the same in the arrangement in accordance with the invention as in the prior art arrangement of Figure 1. Clearly,

the embodiment of Figures 2 to 7 is distinguished from the prior art arrangement of Figure 1 in that in order to remove the bucket 1 in the former it is not necessary to release the pivot pins defining pivot axes 9 and 4.

Also welded to the base plate 14 and extending in the opposite direction to the flanges 12 and 13, are spaced side walls 18 and 19 which have extending between them at the forward end thereof adjacent the pivot axis 4, a hook member 20. The hook member 20 defines a forwardly open (in the direction of excavation of the bucket 1) closed end portion 21 capable of receiving a securing pin 4' on the bucket 1, a forwardly extending flat 22, and a raised lip 23.

At their opposite rear end, the spaced side walls 18 and 19 define a rebate 24 which is capable of receiving the securing pin 9' of the bucket 1, the spacing of the recess 21 and rebate 24 being substantially equal to the spacing of the pins 4' and 9' whereby in order to engage both pins, it is necessary for the pin 4' to be fully engaged in the closed end portion 21 before the rebated portion 24 can be moved to receive the pin 9'.

Also extending between the side walls 18 and 19 at the rear end of the coupling are two spaced slide plates 25 and 26. The slide plates 25 and 26 define between them a slide passage which extends through part of the length of the coupling and opens at the rear end onto the rebate 24. Slideably mounted in the slide passage is a slide member 27 of generally U-shaped configuration with closed sides, the external surface of the base of the U-shape defining a groove 28 also capable of receiving the securing pin 9' when the slide member is projected from the slide passage into a locking position. In the locking position, a side portion 29 of the groove 28 further encompasses the securing pin 9' to prevent

withdrawal of the pin from the rebate 24 (to the right as shown in Figure 4). Partly located between the legs 30 (only one shown) of the U-shaped slide member 27 is a hydraulic ram 31 whose piston rod 32 is pivotally secured to the slide member. At its other end, the hydraulic ram is pivotally secured to a mounting bracket 33 welded to the base plate 14.

The slide plate 24 defines an outer end 34 of the rebate 24 over which the securing pin 9' must be passed to enter the rebate. The end surfaces of the side walls 18 and 19 define a side surface 35 and a bottom surface 36 of the rebate, the side surface being that surface of the rebate which is closest to the closed portion 21 of the hook means. The groove 28 of the slide member 27 acts to hold the securing pin 9' against the bottom and side surfaces, and it will be noted that the distance of the side surface 35 from the closed end portion 21 of the hook means does not increase from that part of the side surface adjacent the bottom surface to the outer end 34. This allows the securing pin 9' to be closely received in the rebate 24 as the bucket is pivoted about the securing pin 4' received in the closed end portion 21 of the hook means, and therefore to minimise the amount of movement permitted by the coupling in the plane of the securing pins 4' and 9', with the advantage that the projection of the slide member 27 into the rebate is reduced and that the rebate 24 bears the brunt of forward movement of the bucket and securing pin 9' rather than the slide member 27 and hydraulic ram 31 in the locking position of the slide member. In practice a maximum spacing of about 10mm is preferred between the side surface 35 and the securing pin 9' when the slide member is in the locking position.

Referring now to Figures 6 and 7, a pair of compression springs 37 extend through the slide passage between the slide member 27 and the forward end of the coupling body, substantially in the plane of and on respective sides of the hydraulic ram 31. The compression springs are located at the forward end of the coupling body by respective studs 38 welded to the body and extend through respective tube members 39 slightly over-diameter compared to the springs which are welded to the inner end of the slide member 27. The springs extend through the tube members into the generally U-shaped configuration of the slide member and abut the inner surface of the base thereof. The springs 39 act to bias the slide member 27 into the locking position and to hold the slide member there even if hydraulic pressure is lost from the hydraulic ram 31. In a preferred embodiment where the ram has an internal diameter of 3 inches and a maximum stroke of 3 3/4 inches producing a force of up to 3500 psi on the slide member, each spring 37 may have an overall free length of 10 inches compressed to about 8 inches in the locking position and about 7½ to 7 3/4 inches in the release position, with 19 coils of 7.1mm diameter wire coiled to an outside diameter of 1 15/16 inches.

The tube members 39 and side walls of the slide member 27 resist lateral movement of the springs in the event of breakage or distortion.

Actuation of the hydraulic ram 31 is by means of the fluid pressure supply circuit 40 shown schematically and non-restrictively in Figure 8. Earth working apparatus of the type on which the coupling of the invention will be used will invariably include a plurality of hydraulic circuits for operating, for example, the bucket ram 6 shown in Figure 1 as well as a boom extending ram, a hammer circuit and so forth. All

these circuits may be tapped off a ring circuit illustrated as 41 in Figure 8 and including a motor driven pump 42, a reservoir 43 for hydraulic fluid, a flow line 44 and a return flow filter 45 immediately upstream of the reservoir. Various pressure relief valves, one-way valves and restrictor valves (not shown) may be provided in the ring circuit 41 as will be clear to the man in the art.

Tapped off the ring circuit 41 is the hydraulic ram circuit 46 including a flow line 47. A two-way spool valve 48 is provided in the flow line 47 with a one-way check valve 49 in the flow line 44 between the input to and return from the valve 48. Valve 48 is hydraulically operated from the cab of the earth working apparatus in known manner by a lever arrangement (not shown) which is preferably biased into a position which holds the valve in the closed condition illustrated. The spool valve 48 may be a spare valve provided in the hydraulic circuit or the spool valve for controlling the bucket ram 6 with lines for the hydraulic ram 31 control tapped off the bucket ram circuit. In the open condition the valve 48 permits fluid flow into the flow line 47. In another arrangement the valve 48 is replaced by a diverter valve.

A three-way valve 50 is provided downstream of the valve 48 and also has a neutral position preventing flow of fluid through the line 47 into which it is biased. The valve 50 controls the direction of fluid flow into the hydraulic ram 31 according to whether the ram is to be extended or retracted. The valve 50 may also be hydraulically operated from the cab but since substantial additional control apparatus would normally be required on the apparatus, it is preferred to provide control by means of an electric solenoid arrangement (not shown) by which a three-way electric switch is provided in the cab and biased into a neutral position in which

the valve 50 is held in its central closed condition illustrated. Movement of the switch in one direction out of the neutral position actuates a first solenoid to move the valve spool correspondingly and permit fluid flow in one direction, while movement of the switch in the opposite direction actuates a second solenoid for the opposite result.

It will be noted that in order to provide fluid flow to the ram 31 both valves 48 and 50 must be actuated and in order to provide an additional safety measure, the levers and/or switches for controlling the valves are spaced from one another sufficiently that they cannot be operated together by one hand.

Between the valve 50 and the hydraulic ram 31 is a failsafe two-way valve 51 provided to ensure that pressure will be maintained in the ram if there is pressure loss between the valve 51 and the ring circuit 44. Many types of such valve are known and that described is by way of example only. The valve 51 has a spool 52 biased into a central position by opposed springs 53 in which fluid flow through the valve is prevented. When fluid pressure is applied to one end of the spool 52 the spool is displaced thereby to open the corresponding end of the housing of valve 51 to a port leading to the hydraulic ram. A passage 54 through the other end of the spool communicates a return port from the ram with the return side of the line 47. A corresponding passage 54 is provided through the one end of the spool 52 to relieve fluid pressure in the ram 31 when fluid pressure from valve 50 is applied to the other end of the spool 52 in order to reverse movement of the hydraulic ram. When fluid flow through valve 51 is stopped by closing one or both valves 48 and 50, the spool 52 is biased to its neutral closed condition as the forces at each end balance out.

The hydraulic ram circuit 46 has also been described for convenience only without reference to additional one-way check valves, relief valves and restrictor valves, the location of all or any of which may be readily assumed by the man in the art.

In order to release the bucket 1 in the embodiment of Figures 2 to 7, the slide member 27 is retracted by opening valve 48 and moving the spool of valve 50 to the left in Figure 8, the coupling 11 is pivoted by means of the hydraulic actuator 6 acting through the link 8, to separate the rebate 24 from the securing pin 9' and the coupling is then raised by means of the boom 3 to release the pin 4' from the hook 20.

The hook 20 shown in Figure 4 is of a preferred form since it is believed to most securely locate and hold the securing pin 4', but a further embodiment of hook 20' is shown in Figure 5 in which the flat 22 and lip 23 of the hook 20 are merged into an inclined flat surface 55.

It is believed that the coupling described herein is equally useful with a back hoe or other earth working machine to secure an earth working implement. Experimentation has shown that the operation of removing one tool from a hydraulic excavator and replacing it with another one using the coupling herein described may take only 30 seconds as compared to 30 minutes for the prior art arrangement described with reference to Figure 1.

In addition the coupling includes many safety features, including the spacing of the hook means and rebate, the spring biassing means, the two-handed control arrangement, and the failsafe check valve.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A coupling for detachably mounting a tool having two mounting members on earth working apparatus, the coupling comprising a coupling body, means in said body to enable securement thereof to the apparatus, hook means on the coupling body and adapted to extend part way around a first of the mounting members, recess means in the coupling body and adapted to receive the second of the mounting members with the hook means and recess means being arranged such that the hook means must be engaged before the recess means with the respective mounting members, hydraulically operable securing means disposed in the coupling body and moveable relative thereto between a locking position in which withdrawal of the second mounting member from the recess means is prevented when the first mounting member is received in the hook means and a release position in which such withdrawal is permitted, and spring biassing means which acts to bias the securing means into the locking position.

2. A coupling as claimed in Claim 1 in which the spring biassing means comprises at least one compression spring acting between the coupling body and the securing means.

3. A coupling as claimed in Claim 2 in which the or each compression spring is restrained over at least part of its length from lateral displacement.

4. A coupling as claimed in either of Claims 2 and 3 in which a hydraulic ram extends between the coupling body and the securing means and wherein two compression springs are provided on respective sides of the hydraulic ram.

5. A coupling as claimed in any one of the preceding claims in which the recess means has an open outer end through which the second mounting member is displaceable for introduction into and withdrawal from

the recess means when the first mounting member is received in the hook means, and wherein the securing means comprises a locking element which at least partly closes the outer end of the recess means when the securing means is in the locking position.

6. A coupling as claimed in Claim 5 in which the securing means comprises a grooved end face for receiving the second mounting member, with the locking element defining one limb of said groove.

7. A coupling as claimed in any one of the preceding claims in which the securing means is slidable through guide means disposed in the coupling body.

8. A coupling as claimed in any one of the preceding claims in which the recess means in the coupling body comprises a side surface at the side thereof closest to the hook means which at least partly defines an outer end of the recess means and the securing means acts to secure the second mounting member in the recess means at a preselected position along the side surface inwardly of said outer end, and the hook means comprises a closed end portion in which the first mounting member is received during use and opens generally away from the recess means, and wherein the spacing of the side surface of the recess means from the closed portion of the hook means does not increase from said preselected position towards said outer end.

9. A coupling as claimed in Claim 8 in combination with a tool mounted thereby and wherein the spacing of the mounting members is substantially equal to said spacing between the closed portion of the hook means and the preselected position along the side surface of the recess means whereby displacement of the tool relative to the coupling in the plane of the mounting members is restrained by the hook means and the side surface.

10. A coupling as claimed in any one of the preceding claims in which the recess means includes a bottom surface in abutment with which the securing means is adapted to hold the second mounting member.

11. Earth working apparatus including a boom and a coupling as claimed in any one of the preceding claims mounted on the boom and including a hydraulic ram for displacing the securing means between the locking and release positions, said apparatus including fluid pressure supply means for the hydraulic ram.

12. Earth working apparatus as claimed in Claim 11 in which the fluid pressure supply means comprises valve means disposed in a parallel circuit with the hydraulic ram which is biased into a closed position to prevent loss of pressure from the hydraulic ram when there is no fluid pressure supply thereto and which opens to direct fluid pressure to the hydraulic ram.

13. Earth working apparatus as claimed in Claim 11 or Claim 12 in which the fluid pressure supply means includes two manually controlled valves both of which must be opened to direct fluid pressure to the hydraulic ram.

14. Earth working apparatus as claimed in Claim 13 in which at least one of the manually controlled valves is electrically actuated.

15. A coupling substantially as herein described with reference to Figures 2 to 4, 6 and 7 or as modified with reference to Figure 5 of the accompanying drawings.

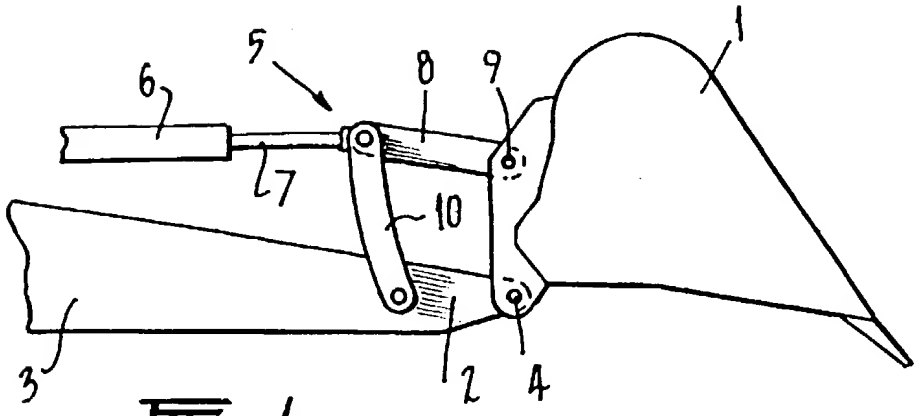
16. Earth working apparatus as claimed in Claim 11 in which the coupling is as claimed in Claim 15.

17. Earth working apparatus as claimed in Claim 11 or Claim 16 in which the fluid pressure supply means is substantially as herein described with reference to Figure 8 of the accompanying drawings.

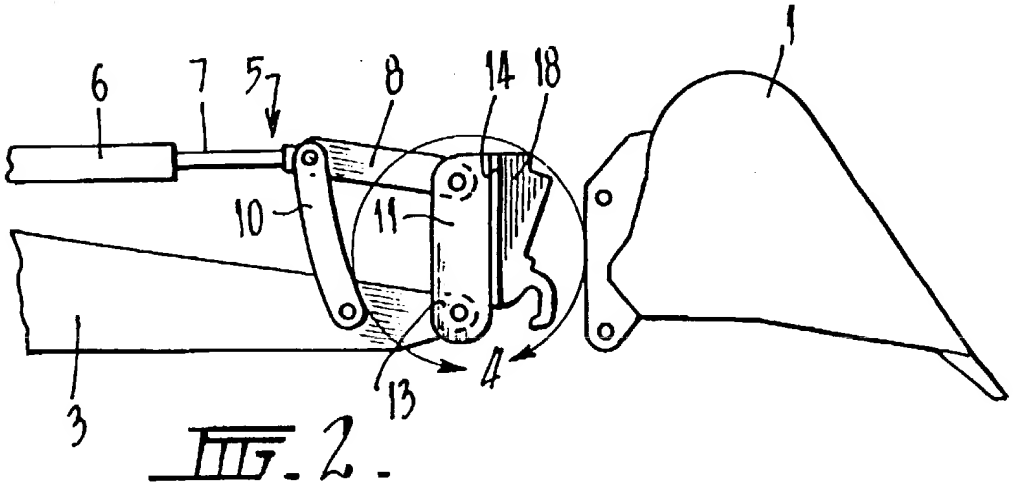
DATED THIS 16th day of November, 1984

REDBAR PLANT HIRE PROPRIETARY LIMITED
By Its Patent Attorneys

CLEMENT HACK & CO.
Fellows Institute of Patent
Attorneys of Australia



Фиг. 1.



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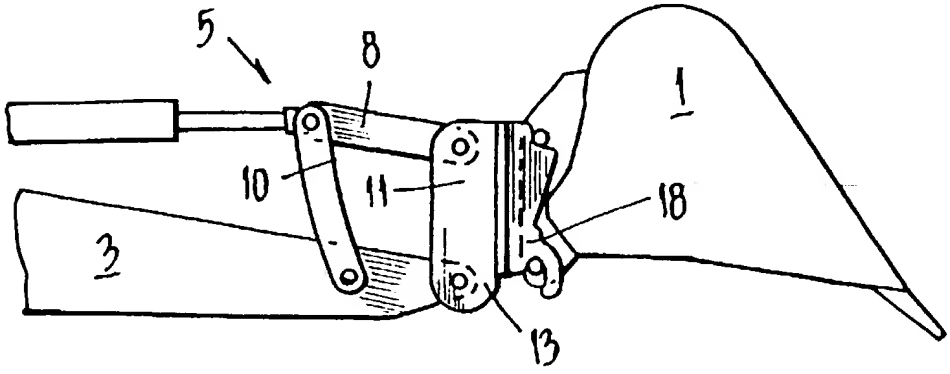

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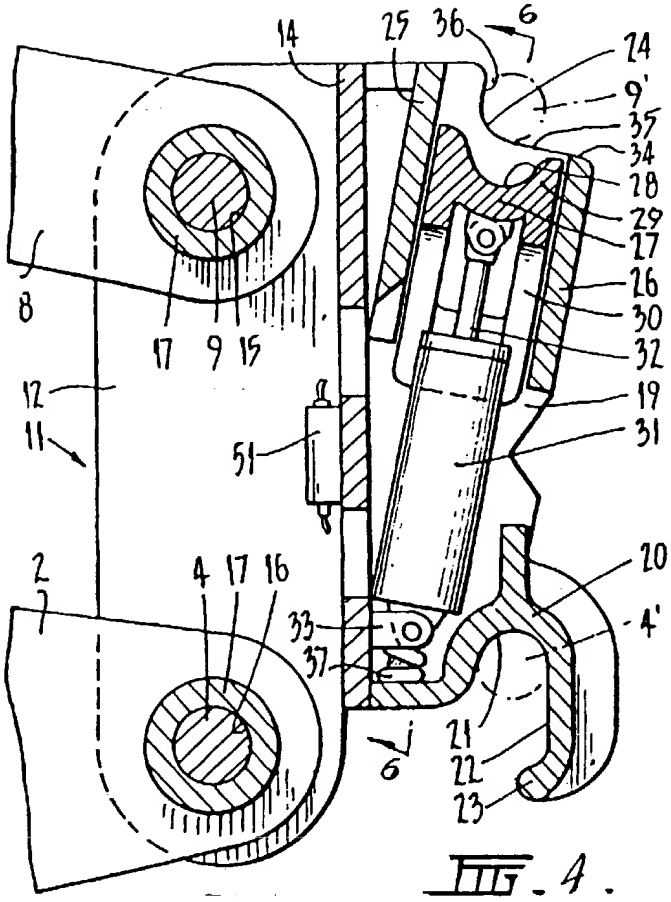
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FIG. 4.

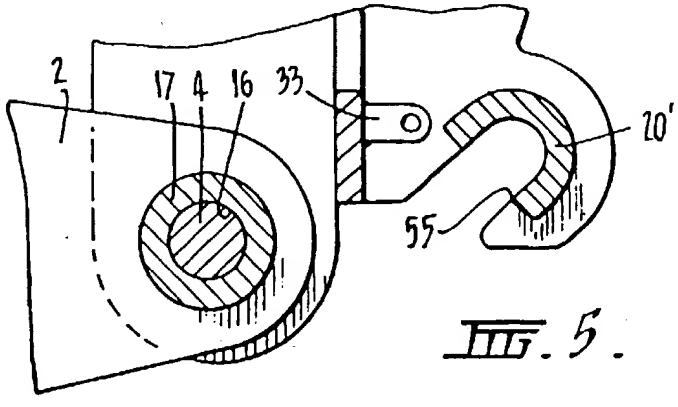
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FIG. 5.

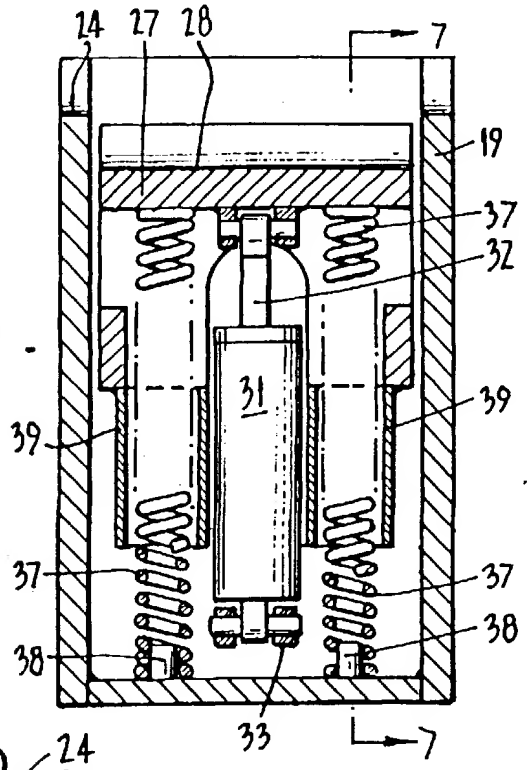
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FIG. 6.

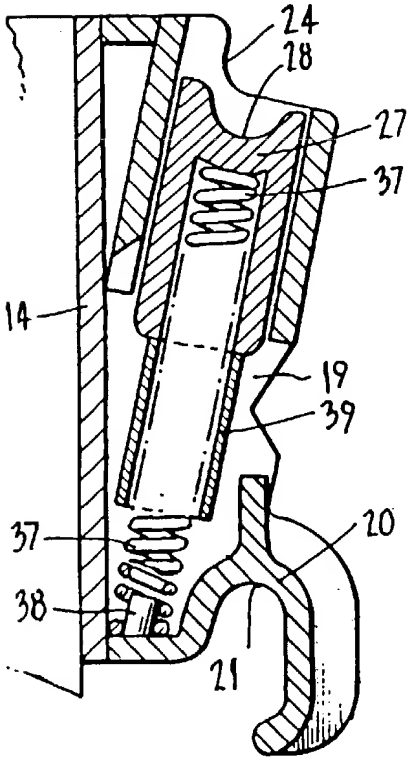
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FIG. 7.

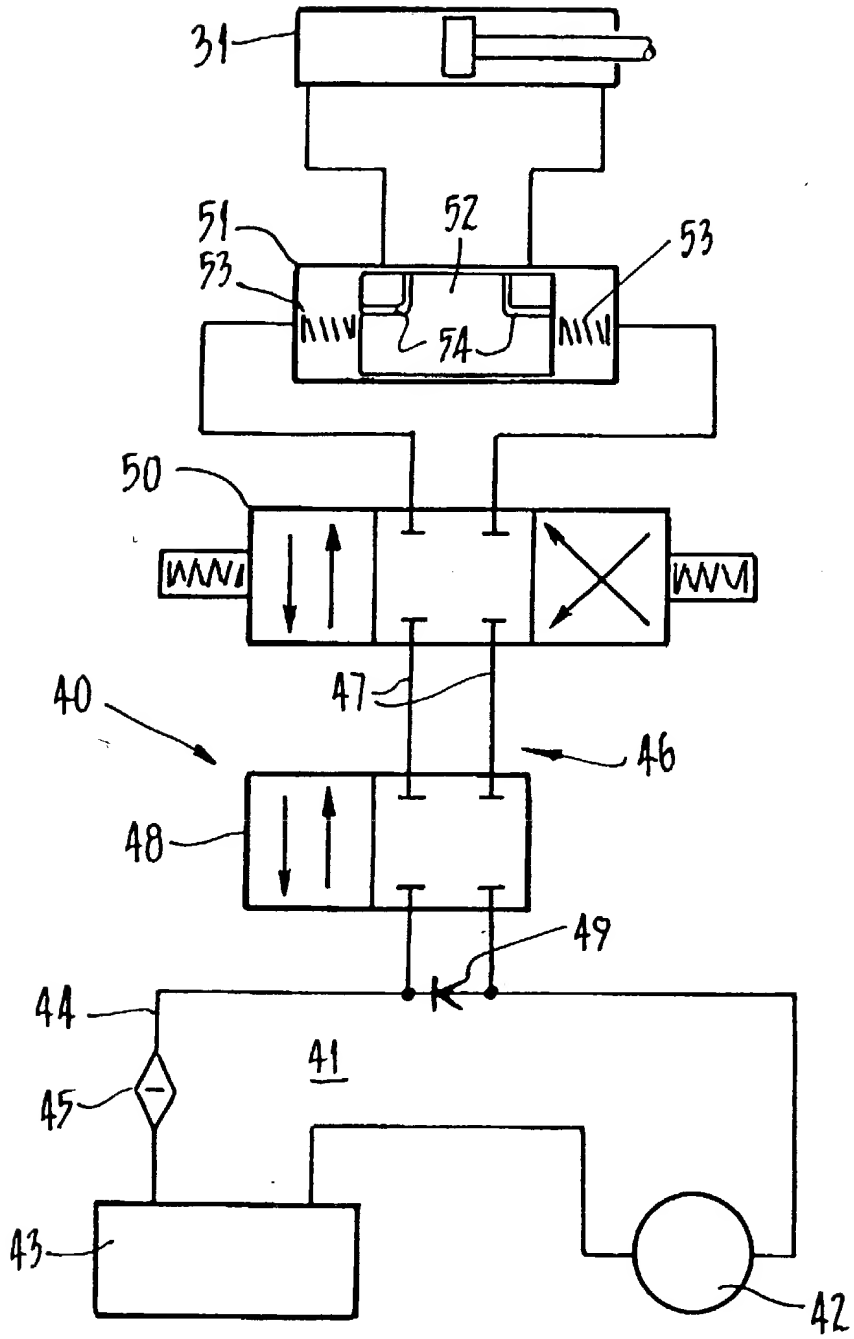

FIG. 8.